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(54) Title: FLEXIBLE RADIO ACCESS TECHNOLOGY SELECTION POLICY FOR 5G MOBILE COMMUNICATIONS

(57) Abstract: Examples pertaining to flexible radio access technology (RAT) selection for 5th Generation (5G) mobile communications are described. A user equipment (UE) may receive, from a network node of a wireless network, information related to a RAT preference with respect to RAT selection by the UE. Based at least in part on the received information, the UE may perform a RAT or Public Land Mobile Network (PLMN) selection procedure. Alternatively, or additionally, the UE may receive, from the network node, information related to ability of one or more neighbor network nodes of one or more RATs in a region. Based at least in part on the received information, the UE may select one of the one or more RATs or one of the one or more neighbor network nodes.

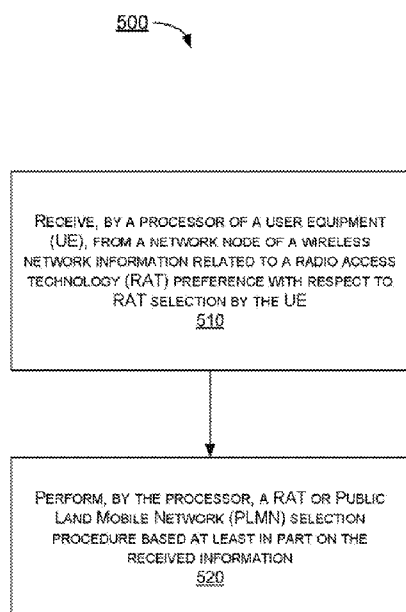


FIG. 5

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FLEXIBLE RADIO ACCESS TECHNOLOGY SELECTION POLICY FOR 5G MOBILE COMMUNICATIONS

CROSS REFERENCE TO RELATED PATENT APPLICATION(S)

5 **[0001]**The present disclosure is part of a non-provisional application claiming the priority benefit of U.S. Patent Application No. 62/717,352, filed on 10 August 2018, the content of which being incorporated by reference in its entirety.

TECHNICAL FIELD

10 **[0002]**The present disclosure is generally related to mobile communication sand, more particularly, to a flexible radio access technology (RAT) selection policy for 5th Generation (5G) mobile communications.

BACKGROUND

15 **[0003]**Unless otherwise indicated herein, approaches described in this section are not prior art to the claims listed below and are not admitted as prior art by inclusion in this section.

[0004]Under the 3rd-Generation Partnership Project (3GPP) specifications, there are several options for system/network architecture of 5G mobile communications including, among others, Option 3 and Option 2. With Option 3, the system is of a non-standalone (NSA) type with Evolved Packet Core (EPC) having Long-Term Evolution (LTE)-anchored radio access network (RAN) with dual connectivity (DC). With Option 2, the
20 system is of a standalone (SA) type with 5G core network (CN) having New Radio (NR) RAN. As network operators roll out 5G deployment, the architecture of more and more mobile communication networks will change from that of Option 3 to Option 2. Thus, there will be coexistence of cells supporting Option 3, cells supporting Option 2, and cells supporting both Option 3 and Option 2.

[0005]Generally, in terms of system selection, RAT preference is pre-configured per Public Land Mobile
25 Network (PLMN). For example, the RAT preference in a descending order may be next-generation RAN (NG-RAN) over evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (E-UTRAN) over UMTS Terrestrial Radio Access Network (UTRAN) over Global System for Mobile Communications (GSM). Depending on the deployment strategy, some network operators may deploy Option-2 networks regionally at the very beginning (e.g., deploying Option-2 networks only in large cities
30 initially). Consequently, poor user experience could result if a user equipment (UE) applies a general RAT selection policy nationwide. Thus, when an Option 2-supported UE searches for NR cells for access to a 5G core (5GC), how the UE can avoid selecting NR cells for Option 3 only is an issue that needs to be resolved.

SUMMARY

35 **[0006]**The following summary is illustrative only and is not intended to be limiting in any way. That is, the following summary is provided to introduce concepts, highlights, benefits and advantages of the novel and non-obvious techniques described herein. Select implementations are further described below in the detailed description. Thus, the following summary is not intended to identify essential features of the claimed subject matter, nor is it intended for use in determining the scope of the claimed subject matter.

[0007]An objective of the present disclosure aims to provide schemes, solutions, concepts, designs, methods and systems pertaining to a flexible RAT selection policy for 5G mobile communications. In other words, the present disclosure aims to address the issue of how a UE can avoid selecting NR cells for Option 3 only as the UE searches for NR cells for access to a 5GC. More specifically, the present disclosure describes proposed schemes pertaining to steering of the RAT selection policy for UEs, and the present disclosure also describes proposed schemes pertaining to network-assisted RAT selection policy for UEs.

[0008]In one aspect, a method may involve a processor of a UE receiving, from a network node of a wireless network, information related to a RAT preference with respect to RAT selection by the UE. The method may also involve the processor performing a RAT or PLMN selection procedure based at least in part on the received information.

[0009]In another aspect, a method may involve a processor of a UE receiving, from a network node of a wireless network, information related to ability of one or more neighbor network nodes of one or more radio access technologies (RATs) in a region. The method may also involve the processor selecting one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the received information.

[0010]It is noteworthy that, although description provided herein may be in the context of certain radio access technologies, networks and network topologies such as 5G and NR, the proposed concepts, schemes and any variation(s)/derivative(s) thereof may be implemented in, for and by other types of radio access technologies, networks and network topologies such as, for example and without limitation, LTE, LTE-Advanced, LTE-Advanced Pro, UMTS, GSM, and . Thus, the scope of the present disclosure is not limited to the examples described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of the present disclosure. The drawings illustrate implementations of the disclosure and, together with the description, serve to explain the principles of the disclosure. It is appreciable that the drawings are not necessarily in scale as some components may be shown to be out of proportion than the size in actual implementation in order to clearly illustrate the concept of the present disclosure.

[0012]FIG. 1 is a diagram of an example scenario in which a proposed scheme in accordance with the present disclosure may be implemented.

[0013]FIG. 2 is a diagram of an example scenario in which a proposed scheme in accordance with the present disclosure may be implemented.

[0014]FIG. 3 is a diagram of an example scenario in which a proposed scheme in accordance with the present disclosure may be implemented.

[0015]FIG. 4 is a block diagram of an example communication apparatus and an example network apparatus in accordance with an implementation of the present disclosure.

[0016]FIG. 5 is a flowchart of an example process in accordance with an implementation of the present disclosure.

[0017]FIG. 6 is a flowchart of an example process in accordance with an implementation of the present disclosure.

DETAILED DESCRIPTION OF PREFERRED IMPLEMENTATIONS

[0018]Detailed embodiments and implementations of the claimed subject matters are disclosed herein. However, it shall be understood that the disclosed embodiments and implementations are merely illustrative of the claimed subject matters which may be embodied in various forms. The present disclosure may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments and implementations set forth herein. Rather, these exemplary embodiments and implementations are provided so that description of the present disclosure is thorough and complete and will fully convey the scope of the present disclosure to those skilled in the art. In the description below, details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the presented embodiments and implementations.

Overview

[0019]Implementations in accordance with the present disclosure relate to various techniques, methods, schemes and/or solutions pertaining to a flexible RAT selection policy for 5G mobile communications. According to the present disclosure, a number of possible solutions may be implemented separately or jointly. That is, although these possible solutions may be described below separately, two or more of these possible solutions may be implemented in one combination or another.

[0020]RAT selection policy is crucial to search performance of a device (e.g., UE) that supports multiple RATs. One main consideration with respect to RAT preference in the selection should be network deployment. In general, the preference is pre-configured per PLMN. However, deployment of RATs may be changed dynamically in different scopes (e.g., nationwide, within a PLMN, within specific tracking area(s) (TAs), or within specific registration area(s) (RAs)). For instance, deployment of RATs may change due to phase-out of legacy RATs (e.g., spectrum re-farming of GSM), introduction of new RATs (e.g., 5G) in large cities initially, and access to specific RATs being forbidden temporarily (e.g., due to network device update). Thus, it is possible that a UE may camp on a RAT or cell with lower performance when there is another RAT or cell with higher performance due to search mechanism of the UE. Consequently, user experience may be negatively impacted as user experience is determined by the RAT or cell on which the UE is camped (e.g., NR > LTE, LTE NSA cell > LTE-only cell, and LTE with bandwidth of 10MHz > LTE with bandwidth of 1.4MHz).

[0021]In view of the above, it can be seen that the pre-configuration of RAT selection order (or lack thereof) may result in poor user experience after the deployment has changed. For instance, at the beginning, 5G is deployed in a small number of cities. In an event that a UE is configured to search for 4G first, then there may be poor performance in cities with 5G deployed. On the other hand, in an event that the UE is configured to search for 5G first, then there may be poor performance in cities without 5G. As time goes on, with 5G deployed nationwide, for UEs configured to search for 4G first there may be poor performance anywhere in the country.

[0022]Thus, it is essential to update the RAT preference of UEs so as to be able to timely adjust to network deployment and be configured on a location basis (e.g., the RAT selection preference may vary as the location of the UE varies). Under a proposed scheme in accordance with the present disclosure, a network

operator may steer RAT selection by sending a downlink signal to update the RAT preference of UEs on a location basis. Under the proposed scheme, configuration of RAT preference provided by the network may be stored in a memory device of the UE, a Subscriber Identity Module (SIM) in the UE, or both. For instance, the configuration may supersede or otherwise take preference over (e.g., by overwriting) existing settings (e.g.,

5 EF_{HPLMNwACT}, EF_{OPLMNwACT}, or other related settings stored in UE). The UE may consider the network-provided RAT preference in a subsequent PLMN/RAT search procedure.

[0023] Additionally, currently a cell may broadcast system information to assist UEs to camp on a higher-priority RAT. However, for a specific RAT, the network does not indicate which cell or frequency has better performance or capacity. Although the network can redirect or handover a UE based on measurement result or

10 UE capacity, the network may not take user experience into consideration. Consequently, the UE may stay camped on a cell with lower performance. Under a proposed scheme in accordance with the present disclosure, the network may broadcast system information (or transmit dedicated signaling) to assist UEs to camp on cell with higher performance. The system information may include a neighbor frequency list with information related to bandwidths, frequencies and/or capacities of one or more neighbor cells. In an even that the

15 information is provided via an NR cell, the information may be carried in system information. In an even that the information is provided via an LTE cell, pertinent information (which may include bandwidth information, carrier aggregation capacity, EN-DC capacity) may be carried in system information. In an even that the information is provided via a UMTS/GSM cell, pertinent information (e.g., release version) may be carried in system information. Moreover, under the proposed scheme, the network may, based on UE capability,

20 transmit a redirection or handover command to the UE in an event that there exists a RAT/cell with higher performance near the cell on which the UE is currently camped.

[0024] FIG. 1 illustrates an example scenario 100 in which a first proposed scheme in accordance with the present disclosure may be implemented. Scenario 100 may involve a UE 110 and several cells 120(1) ~ 120(N), with N being a positive integer greater than 1. UE 110 may be capable of wireless communications in

25 an Option-2 mobile communication system. In FIG. 1, cell 120(1) is a first LTE cell (denoted as “LTE1”) with a frequency capacity of 20MHz and EN-DC capability, cell 120(2) is a second LTE cell (denoted as “LTE2”) with a frequency capacity of 10MHz, cell 120(3) is a first NR cell (denoted as “NR1”) with a frequency capacity of 20MHz and supporting Option 2, cell 120(4) is a second NR cell (denoted as “NR2”) with a frequency capacity of 100MHz and supporting Option 2, cell 120(5) is a third NR cell (denoted as “NR3”) with a frequency capacity of 50MHz and supporting Option 2, and cell 120(6) is a fourth NR cell (denoted as “NR4”) supporting Option 3 but not Option 2.

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[0025] Under the first proposed scheme, to achieve flexible RAT selection for 5G mobile communications, a network may provide additional information about neighbor cells/network nodes to a UE (e.g., UE 110). Under the proposed scheme, the network may, via a network node (e.g., eNB or gNB), broadcast information

35 related to frequency capacity (e.g., frequencies and/or bandwidths) of one or more neighbor cells/network nodes to UEs within a cell associated with the network node. For instance, in addition to other information that would normally be broadcasted, the network node may also broadcast information related to frequencies and/or bandwidths of one or more neighboring Option-2 cells in system information (e.g., carried in system information block (SIB)). The frequencies thus indicated may be used by UEs for inter-RAT/system cell

40 selection. Moreover, once a UE determines that a current cell on which the UE is camped does not support

Option 2, the UE may perform either of two actions. That is, in an event that the received information includes information about one or more Option-2 NR cells in the region, the UE may search for a cell that supports Option 2 of 5G network architecture immediately. Alternatively, in an event that the received information does not include information about one or more Option-2 NR cells in the region, the UE may search for an

[0026] In scenario 100, the network broadcasts, via cell 120(2), system information to a plurality of UEs including UE 110 to steer the RAT selection policy thereof. The system information includes information related to frequencies and additional capability of neighboring LTE cells and Option-2 NR cells. As shown in FIG. 1, the information indicates 20MHz and EN-DC capability for LTE1, 10MHz for LTE2, 20MHz for NR1, 100MHz for NR2, and 50MHz for NR3. Accordingly, UE 110 may overwrite its pre-configured settings with the received information as well as utilize the received information in RAT selection.

[0027] FIG. 2 illustrates an example scenario 200 in which a second proposed scheme in accordance with the present disclosure may be implemented. Scenario 200 may involve UE 110 moving from one location to another, such as from a region associated with a first PLMN or TA (denoted as "PLMN₁/TA₁") to a second PLMN or TA (denoted as "PLMN₂/TA₂"), as shown in FIG. 2. In this example, the first PLMN or TA includes some LTE cells and some NR cells, and the second PLMN or TA includes some UMTS cell and some LTE cells.

[0028] Under the second proposed scheme, to achieve flexible RAT selection for 5G mobile communications, a network may provide regional RAT preference to a UE (e.g., UE 110) by transmitting information related to neighbor cell capacity to the UE as location of the UE changes. Under the proposed scheme, the network may provide RAT preference to the UE via a new SIB or downlink message on the basis of a smaller region (e.g., TA list). The new configuration of RAT preference may preempt a default configuration stored in SIM or a memory device (e.g., non-volatile random-access memory (NVRAM)) of the UE, and the UE may apply the new configuration immediately or in a next search procedure.

[0029] In scenario 200, when UE 110 is in a location associated with PLMN₁/TA₁, the network transmits, via one of the LTE cells, RAT preference to UE 110. As there are NR cells and LTE cells in PLMN₁/TA₁, the RAT preference thus transmitted to UE 110 pertains to a RAT selection preference with respect to those NR cells and LTE cells in PLMN₁/TA₁. When UE 110 is in a location associated with PLMN₂/TA₂, the network transmits, via one of the UMTS cells, RAT preference to UE 110. As there are LTE and UMTS cells in PLMN₂/TA₂, the RAT preference thus transmitted to UE 110 pertains to a RAT selection preference with respect to those LTE cells and UMTS cells in PLMN₂/TA₂.

[0030] FIG. 3 illustrates an example scenario 300 in which a third proposed scheme in accordance with the present disclosure may be implemented. Scenario 300 may involve UE 110 and two or more cells such as, for example and without limitation, cells 120(1), 120(3) and 120(5).

[0031] Under the third proposed scheme, to achieve flexible RAT selection for 5G mobile communications, a network may redirect a UE (e.g., UE 110) to a target cell. Under the proposed scheme, a network may, via dedicated signaling, indicate to the UE a presence of one other RAT or cell with higher performance than a current cell on which the UE is camped in terms of bandwidth, carrier aggregation, or both. For instance, the network may transmit a redirection or handover command to the UE to cause the UE to perform a redirection of handover procedure to camp on that other RAT or cell with higher performance.

Typically, the UE would try to establish radio resource control (RRC) connection on an NR cell for Option 3 only. In an event that there are NR cells supporting Option 2 nearby, the network may redirect the UE to an Option 2-supporting cell via a redirection or handover procedure. Otherwise, in an event that there are LTE cells nearby, the network may redirect the UE to an LTE cell via a redirection or handover procedure. Under the proposed scheme, an NR cell supporting Option 3 only may be configured as a barred cell or as not supporting RRC establishment procedure.

[0032] In scenario 300, cell 120(3) which supports Option 3 may transmit a redirection or handover command to UE 110. In response to receiving the command, UE 110 may perform a redirection or handover procedure with either cell 120(1) or cell 120(5).

Illustrative Implementations

[0033] FIG. 4 illustrates an example communication environment 400 having an example apparatus 410 and an example apparatus 420 in accordance with an implementation of the present disclosure. Each of apparatus 410 and apparatus 420 may perform various functions to implement schemes, techniques, processes and methods described herein pertaining to flexible RAT selection for 5G mobile communications, including various schemes described above as well as processes 500 and 600 described below.

[0034] Each of apparatus 410 and apparatus 420 may be a part of an electronic apparatus, which may be a UE such as a portable or mobile apparatus, a wearable apparatus, a wireless communication apparatus or a computing apparatus. For instance, each of apparatus 410 and apparatus 420 may be implemented in a smart phone, a smart watch, a personal digital assistant, a digital camera, or a computing equipment such as a tablet computer, a laptop computer or a notebook computer. Each of apparatus 410 and apparatus 420 may also be a part of a machine type apparatus, which may be an IoT or NB-IoT apparatus such as an immobile or a stationary apparatus, a home apparatus, a wire communication apparatus or a computing apparatus. For instance, each of apparatus 410 and apparatus 420 may be implemented in a smart thermostat, a smart fridge, a smart door lock, a wireless speaker or a home control center. Alternatively, each of apparatus 410 and apparatus 420 may be implemented in the form of one or more integrated-circuit (IC) chips such as, for example and without limitation, one or more single-core processors, one or more multi-core processors, or one or more complex-instruction-set-computing (CISC) processors. Each of apparatus 410 and apparatus 420 may include at least some of those components shown in FIG. 4 such as a processor 412 and a processor 422, respectively. Each of apparatus 410 and apparatus 420 may further include one or more other components not pertinent to the proposed scheme of the present disclosure (e.g., internal power supply, display device and/or user interface device), and, thus, such component(s) of each of apparatus 410 and apparatus 420 are neither shown in FIG. 4 nor described below in the interest of simplicity and brevity.

[0035] In some implementations, at least one of apparatus 410 and apparatus 420 may be a part of an electronic apparatus, which may be a network node or base station (e.g., eNB, gNB or transmit/receive point (TRP)), a small cell, a router or a gateway. For instance, at least one of apparatus 410 and apparatus 420 may be implemented in an eNodeB in an LTE, LTE-Advanced or LTE-Advanced Pro network, in a gNB in a 5G, NR, IoT or NB-IoT network, or in an access point in a wireless local area network (WLAN). Alternatively, at least one of apparatus 410 and apparatus 420 may be implemented in the form of one or more IC chips such as, for example and without limitation, one or more single-core processors, one or more multi-core processors, or one or more CISC processors.

[0036] In one aspect, each of processor 412 and processor 422 may be implemented in the form of one or more single-core processors, one or more multi-core processors, or one or more CISC processors. That is, even though a singular term “a processor” is used herein to refer to processor 412 and processor 422, each of processor 412 and processor 422 may include multiple processors in some implementations and a single processor in other implementations in accordance with the present disclosure. In another aspect, each of processor 412 and processor 422 may be implemented in the form of hardware (and, optionally, firmware) with electronic components including, for example and without limitation, one or more transistors, one or more diodes, one or more capacitors, one or more resistors, one or more inductors, one or more memristors and/or one or more varactors that are configured and arranged to achieve specific purposes in accordance with the present disclosure. In other words, in at least some implementations, each of processor 412 and processor 422 is a special-purpose machine specifically designed, arranged and configured to perform specific tasks including implementation of a flexible RAT selection policy for 5G mobile communications in accordance with various implementations of the present disclosure.

[0037] In some implementations, apparatus 410 may also include a transceiver 416 coupled to processor 412 and capable of wirelessly transmitting and receiving data. In some implementations, apparatus 410 may further include a memory 414 coupled to processor 412 and capable of being accessed by processor 412 and storing data therein. In some implementations, apparatus 420 may also include a transceiver 426 coupled to processor 422 and capable of wirelessly transmitting and receiving data. In some implementations, apparatus 420 may further include a memory 424 coupled to processor 422 and capable of being accessed by processor 422 and storing data therein. Accordingly, apparatus 410 and apparatus 420 may wirelessly communicate with each other via transceiver 416 and transceiver 426, respectively.

[0038] To aid better understanding, the following description of the operations, functionalities and capabilities of each of apparatus 410 and apparatus 420 is provided in the context of a 5G communication environment in which apparatus 410 is implemented in or as a wireless communication device, a communication apparatus or a UE and apparatus 420 is implemented in or as a network node (e.g., base station 108) connected or otherwise communicatively coupled to a wireless network (e.g., wireless network 105).

[0039] In one aspect of flexible RAT selection for 5G mobile communications, processor 412 of apparatus 410 as a UE may receive, via transceiver 416, from apparatus 420, as a network node of a wireless network, information related to a RAT preference with respect to RAT selection by apparatus 410. Apparatus 420, as a network node, may be a base station or an access point. Additionally, processor 412 may perform, via transceiver 416, a RAT or PLMN selection procedure based at least in part on the received information.

[0040] In some implementations, in performing the RAT or PLMN selection procedure, processor 412 may select a RAT among a plurality of access technologies defined in 3GPP, 3rd Generation Partnership Project 2 (3GPP2), and Institute of Electrical and Electronics Engineers (IEEE) standards.

[0041] In some implementations, in performing the RAT or PLMN selection procedure, processor 412 may perform the RAT or PLMN selection procedure as part of a power-on search, a recovery search, a manual selection, or a higher-priority PLMN search.

[0042] In some implementations, the information related to the RAT preference may include: (i) a list of RATs in a descending or ascending order of preference, (ii) a list of one or more forbidden RATs, (iii) a list of

one or more allowed RATs, or (iv) a combination of two or more of (i), (ii) and (iii). In some implementations, the information related to the RAT preference may be associated with PLMN-related information.

[0043] In some implementations, the information related to the RAT preference may be based on a location of the UE and changes as the location of the UE changes.

5 [0044] In some implementations, in receiving the information related to the RAT preference, processor 412 may receive the information related to the RAT preference via a broadcast message or a signal dedicated to the UE from the network node.

10 [0045] In some implementations, a scope of the information related to the RAT preference may be nationwide, within one or more PLMNs, within one or more tracking areas (TAs), or within one or more registration areas (RAs).

15 [0046] In some implementations, processor 412 may also update stored information related to RAT or PLMN selection with the received information. In such cases, in updating the stored information related to RAT or PLMN selection with the received information, processor 412 may overwrite existing information related to RAT or PLMN selection, which is stored in either or both of a SIM or a memory device associated with the UE, with the received information. In some implementations, the SIM may include a Universal Subscriber Identity Module (USIM) or a profile of an embedded SIM (eSIM), an embedded Universal Integrated Circuit Card (eUICC), an integrated SIM (iSIM), or an integrated UICC (iUICC).

20 [0047] In some implementations, processor 412 may also receive, via transceiver 416, from apparatus 420 information related to ability of one or more neighbor network nodes of one or more RATs in a region. In such cases, in performing the RAT or PLMN selection procedure, processor 412 may select one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the information related to the ability of the one or more neighbor network nodes of the one or more RATs.

25 [0048] In another aspect of flexible RAT selection for 5G mobile communications, processor 412 of apparatus 410 as a UE may receive, via transceiver 416, from apparatus 420, as a network node of a wireless network, information related to ability of one or more neighbor network nodes of one or more RATs in a region. The network node may be a base station or an access point. Moreover, processor 412 may select one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the received information.

30 [0049] In some implementations, the ability of the one or more neighbor network nodes may pertain to a maximum configurable bandwidth for each UE. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to a maximum carrier aggregation configuration. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to support for High-Speed Downlink Packet Access (HSDPA), High-Speed Uplink Packet Access (HSUPA), dual carrier (DC)-HSDPA for one or more UMTS and/or Time Division Synchronous Code Division Multiple Access (TD-SCDMA) neighbor cells. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to support for General Packet Radio Services (GPRS) and/or Enhanced Data rates for GSM Evolution (EDGE) for one or more GSM neighbor cells.

[0050] In some implementations, in receiving the information, processor 412 may receive bandwidth information related to frequency capacity of the one or more neighbor network nodes via broadcast.

[0051] In some implementations, the network node may be associated with an NR cell. In such cases, in receiving the bandwidth information, processor 412 may receive the bandwidth information in system information broadcasted by the network node.

[0052] In some implementations, the network node may be associated with an LTE cell. In such cases, in receiving the bandwidth information, processor 412 may receive the bandwidth information, plus information related to carrier aggregation capacity and EN-DC capability, in system information broadcasted by the network node.

[0053] In some implementations, the network node may be associated with a UMTS or GSM cell. In such cases, in receiving the bandwidth information, processor 412 may receive a release version in system information broadcasted by the network node.

[0054] In some implementations, in selecting one of the one or more RATs or one of the one or more neighbor network nodes, processor 412 may perform certain operations. For instance, processor 412 may search for a cell that supports Option 2 of 5G network architecture responsive to the received information including information about one or more Option-2 NR cells in the region. Alternatively, processor 412 may search for an LTE cell responsive to the received information not including information about any Option-2 NR cell.

[0055] In some implementations, in selecting the one of the one or more RATs, processor 412 may select a RAT among a plurality of access technologies defined in 3GPP, 3GPP2, and IEEE standards.

[0056] In some implementations, in selecting the one of the one or more RATs or one of the one or more neighbor network nodes, processor 412 may select a RAT or network node with a highest data throughput compared to that of other RATs/network nodes. For instance, in a descending order, the preference may be: 5G > 4G EN-DC > 4G non-EN-DC > 3G DC-HSDPA > 3G HSUPA > 3G HSDPA > 3G others > EDGE > GPRS > GSM. In some implementations, in selecting the one of the one or more RATs or one of the one or more neighbor network nodes, processor 412 may select a network node with a highest configurable bandwidth compared to that of other RATs/network nodes.

[0057] In some implementations, processor 412 may perform additional operations. For instance, processor 412 may receive, via transceiver 416, from apparatus 420 a dedicated signaling to apparatus 410 indicating presence of one other RAT or cell with higher performance than a current cell on which apparatus 410 is camped in terms of bandwidth, carrier aggregation, or both. Moreover, processor 412 may perform, via transceiver 416, a redirection or handover procedure to establish a connection with the other RAT or cell responsive to receiving the dedicated signaling. In such cases, the dedicated signaling may include a redirection or handover command to the UE.

Illustrative Processes

[0058] FIG. 5 illustrates an example process 500 in accordance with an implementation of the present disclosure. Process 500 may be an example implementation of the proposed schemes described above with respect to flexible RAT selection for 5G mobile communications in accordance with the present disclosure. Process 500 may represent an aspect of implementation of features of apparatus 410 and apparatus 420. Process 500 may include one or more operations, actions, or functions as illustrated by one or more of blocks 510 and 520. Although illustrated as discrete blocks, various blocks of process 500 may be divided into additional blocks, combined into fewer blocks, or eliminated, depending on the desired implementation.

Moreover, the blocks of process 500 may be executed in the order shown in FIG. 5 or, alternatively, in a different order. Process 500 may also be repeated partially or entirely. Process 500 may be implemented by apparatus 410, apparatus 420 and/or any suitable wireless communication device, UE, base station or machine type devices. Solely for illustrative purposes and without limitation, process 500 is described below in the context of apparatus 410 as a UE (e.g., UE 110) and apparatus 420 as a network node (e.g., eNB or gNB) of a wireless network (e.g., a Wi-Fi basic service set (BSS), an NR cell, an LTE cell or a UMTS cell). Process 500 may begin at block 510.

[0059] At 510, process 500 may involve processor 412 of apparatus 410 as a UE receiving, via transceiver 416, from a network node (e.g., apparatus 420) of a wireless network information related to a RAT preference with respect to RAT selection by apparatus 410. The network node may be a base station or an access point. Process 500 may proceed from 510 to 520.

[0060] At 520, process 500 may involve processor 412 performing, via transceiver 416, a RAT or PLMN selection procedure based at least in part on the received information.

[0061] In some implementations, in performing the RAT or PLMN selection procedure, process 500 may involve processor 412 selecting a RAT among a plurality of access technologies defined in 3GPP, 3GPP2, and IEEE standards.

[0062] In some implementations, in performing the RAT or PLMN selection procedure, process 500 may involve processor 412 performing the RAT or PLMN selection procedure as part of a power-on search, a recovery search, a manual selection, or a higher-priority PLMN search.

[0063] In some implementations, the information related to the RAT preference may include: (i) a list of RATs in a descending or ascending order of preference, (ii) a list of one or more forbidden RATs, (iii) a list of one or more allowed RATs, or (iv) a combination of two or more of (i), (ii) and (iii). In some implementations, the information related to the RAT preference may be associated with PLMN-related information.

[0064] In some implementations, the information related to the RAT preference may be based on a location of the UE and changes as the location of the UE changes.

[0065] In some implementations, in receiving the information related to the RAT preference, process 500 may involve processor 412 receiving the information related to the RAT preference via a broadcast message or a signal dedicated to the UE from the network node.

[0066] In some implementations, a scope of the information related to the RAT preference may be nationwide, within one or more PLMNs, within one or more tracking areas (TAs), or within one or more registration areas (RAs).

[0067] In some implementations, process 500 may further involve processor 412 updating stored information related to RAT or PLMN selection with the received information. In such cases, in updating the stored information related to RAT or PLMN selection with the received information, process 500 may involve processor 412 overwriting existing information related to RAT or PLMN selection, which is stored in either or both of a SIM or a memory device associated with the UE, with the received information. In some implementations, the SIM may include a USIM or a profile of an eSIM, an eUICC, an iSIM, or an iUICC.

[0068] In some implementations, process 500 may further involve processor 412 receiving, via transceiver 416, from the network node information related to ability of one or more neighbor network nodes of one or more RATs in a region. In such cases, in performing the RAT or PLMN selection procedure, process 500 may

involve processor 412 selecting one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the information related to the ability of the one or more neighbor network nodes of the one or more RATs.

[0069] FIG. 6 illustrates an example process 600 in accordance with an implementation of the present disclosure. Process 600 may be an example implementation of the proposed schemes described above with respect to flexible RAT selection for 5G mobile communications in accordance with the present disclosure. Process 600 may represent an aspect of implementation of features of apparatus 410 and apparatus 420. Process 600 may include one or more operations, actions, or functions as illustrated by one or more of blocks 610 and 620. Although illustrated as discrete blocks, various blocks of process 600 may be divided into additional blocks, combined into fewer blocks, or eliminated, depending on the desired implementation. Moreover, the blocks of process 600 may be executed in the order shown in FIG. 6 or, alternatively, in a different order. Process 600 may also be repeated partially or entirely. Process 600 may be implemented by apparatus 410, apparatus 420 and/or any suitable wireless communication device, UE, base station or machine type devices. Solely for illustrative purposes and without limitation, process 600 is described below in the context of apparatus 410 as a UE (e.g., UE 110) and apparatus 420 as a network node (e.g., eNB or gNB) of a wireless network (e.g., a Wi-Fi BSS, an NR cell, an LTE cell or a UMTS cell). Process 600 may begin at block 610.

[0070] At 610, process 600 may involve processor 412 of apparatus 410 as a UE receiving, via transceiver 416, from a network node (e.g., apparatus 420) of a wireless network information related to ability of one or more neighbor network nodes of one or more RATs in a region. The network node may be a base station or an access point. Process 600 may proceed from 610 to 620.

[0071] At 620, process 600 may involve processor 412 selecting one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the received information.

[0072] In some implementations, the ability of the one or more neighbor network nodes may pertain to a maximum configurable bandwidth for each UE. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to a maximum carrier aggregation configuration. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to support for HSDPA, HSUPA, DC-HSDPA for one or more UMTS and/or TD-SCDMA neighbor cells. Alternatively, or additionally, the ability of the one or more neighbor network nodes may pertain to support for GPRS and/or EDGE for one or more GSM neighbor cells.

[0073] In some implementations, in receiving the information, process 600 may involve processor 412 receiving bandwidth information related to frequency capacity of the one or more neighbor network nodes via broadcast.

[0074] In some implementations, the network node may be associated with an NR cell. In such cases, in receiving the bandwidth information, process 600 may involve processor 412 receiving the bandwidth information in system information broadcasted by the network node.

[0075] In some implementations, the network node may be associated with an LTE cell. In such cases, in receiving the bandwidth information, process 600 may involve processor 412 receiving the bandwidth information, plus information related to carrier aggregation capacity and EN-DC capability, in system information broadcasted by the network node.

[0076] In some implementations, the network node may be associated with a UMTS or GSM cell. In such cases, in receiving the bandwidth information, process 600 may involve processor 412 receiving a release version in system information broadcasted by the network node.

[0077] In some implementations, in selecting one of the one or more RATs or one of the one or more neighbor network nodes, process 600 may involve processor 412 performing certain operations. For instance, process 600 may involve processor 412 searching for a cell that supports Option 2 of 5G network architecture responsive to the received information including information about one or more Option-2 NR cells in the region. Alternatively, process 600 may involve processor 412 searching for an LTE cell responsive to the received information not including information about any Option-2 NR cell.

[0078] In some implementations, in selecting the one of the one or more RATs, process 600 may involve processor 412 selecting a RAT among a plurality of access technologies defined in 3GPP, 3GPP2, and IEEE standards.

[0079] In some implementations, in selecting the one of the one or more RATs or one of the one or more neighbor network nodes, process 600 may involve processor 412 selecting a RAT or network node with a highest data throughput compared to that of other RATs/network nodes. For instance, in a descending order, the preference may be: 5G > 4G EN-DC > 4G non-EN-DC > 3G DC-HSDPA > 3G HSUPA > 3G HSDPA > 3G others > EDGE > GPRS > GSM. In some implementations, in selecting the one of the one or more RATs or one of the one or more neighbor network nodes, process 600 may involve processor 412 selecting a network node with a highest configurable bandwidth compared to that of other RATs/network nodes.

[0080] In some implementations, process 600 may involve processor 412 performing additional operations. For instance, process 600 may involve processor 412 receiving, via transceiver 416, from the network node a dedicated signaling to the UE indicating presence of one other RAT or cell with higher performance than a current cell on which the UE is camped in terms of bandwidth, carrier aggregation, or both. Moreover, process 600 may involve processor 412 performing, via transceiver 416, a redirection or handover procedure to establish a connection with the other RAT or cell responsive to receiving the dedicated signaling. In such cases, the dedicated signaling may include a redirection or handover command to the UE.

Additional Notes

[0081] The herein-described subject matter sometimes illustrates different components contained within, or connected with, different other components. It is to be understood that such depicted architectures are merely examples, and that in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0082]Further, with respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

5 [0083]Moreover, it will be understood by those skilled in the art that, in general, terms used herein, and especially in the appended claims, e.g., bodies of the appended claims, are generally intended as “open” terms, e.g., the term “including” should be interpreted as “including but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should be interpreted as “includes but is not limited to,” etc. It will be further understood by those within the art that if a specific number of an introduced claim
10 recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases “at least one” and “one or more” to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles “a” or “an” limits any particular claim containing such introduced claim recitation to
15 implementations containing only one such recitation, even when the same claim includes the introductory phrases “one or more” or “at least one” and indefinite articles such as “a” or “an,” e.g., “a” and/or “an” should be interpreted to mean “at least one” or “one or more;” the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at
20 least the recited number, e.g., the bare recitation of “two recitations,” without other modifiers, means at least two recitations, or two or more recitations. Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, e.g., “a system having at least one of A, B, and C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together,
25 B and C together, and/or A, B, and C together, etc. In those instances where a convention analogous to “at least one of A, B, or C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, e.g., “a system having at least one of A, B, or C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc. It will be further understood by those within the art that virtually
30 any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase “A or B” will be understood to include the possibilities of “A” or “B” or “A and B.”

[0084]From the foregoing, it will be appreciated that various implementations of the present disclosure
35 have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various implementations disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

CLAIMS

1. A method, comprising:

receiving, by a processor of a user equipment (UE), from a network node of a wireless network information related to a radio access technology (RAT) preference with respect to RAT selection by the UE;

and

performing, by the processor, a RAT or Public Land Mobile Network (PLMN) selection procedure based at least in part on the received information.

2. The method of Claim 1, wherein the performing of the RAT or PLMN selection procedure comprises selecting a RAT among a plurality of access technologies defined in 3rd Generation Partnership Project (3GPP), 3rd Generation Partnership Project 2 (3GPP2), and Institute of Electrical and Electronics Engineers (IEEE) standards.

3. The method of Claim 1, wherein the performing of the RAT or PLMN selection procedure comprises performing the RAT or PLMN selection procedure as part of a power-on search, a recovery search, a manual selection, or a higher-priority PLMN search.

4. The method of Claim 1, wherein the information related to the RAT preference comprises:

a list of RATs in a descending or ascending order of preference,

a list of one or more forbidden RATs,

a list of one or more allowed RATs, or

a combination of two or more of above.

5. The method of Claim 4, wherein the information related to the RAT preference is associated with PLMN-related information.

6. The method of Claim 1, wherein the information related to the RAT preference is based on a location of the UE and changes as the location of the UE changes.

7. The method of Claim 1, wherein the receiving of the information related to the RAT preference comprises receiving the information related to the RAT preference via a broadcast message or a signal dedicated to the UE from the network node.

8. The method of Claim 1, wherein a scope of the information related to the RAT preference is nationwide, within one or more PLMNs, within one or more tracking areas (TAs), or within one or more registration areas (RAs).

9. The method of Claim 1, further comprising:

updating, by the processor, stored information related to RAT or PLMN selection with the received information.

10. The method of Claim 9, wherein the updating of the stored information related to RAT or PLMN selection with the received information comprises overwriting existing information related to RAT or PLMN selection, which is stored in either or both of a Subscriber Identity Module (SIM) or a memory device associated with the UE, with the received information.

11. The method of Claim 1, further comprising:

receiving, by the processor, from the network node information related to ability of one or more neighbor network nodes of one or more RATs in a region,

wherein the performing of the RAT or PLMN selection procedure comprises selecting one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the information related to the ability of the one or more neighbor network nodes of the one or more RATs.

12. A method, comprising:

5 receiving, by a processor of a user equipment (UE), from a network node of a wireless network information related to ability of one or more neighbor network nodes of one or more radio access technologies (RATs) in a region; and

selecting, by the processor, one of the one or more RATs or one of the one or more neighbor network nodes based at least in part on the received information.

10 **13.** The method of Claim 12, wherein the receiving of the information comprises receiving bandwidth information related to frequency capacity of the one or more neighbor network nodes via broadcast.

14. The method of Claim 13, wherein the network node is associated with a New Radio (NR) cell, and wherein the receiving of the bandwidth information comprises receiving the bandwidth information in system information broadcasted by the network node.

15 **15.** The method of Claim 13, wherein the network node is associated with a Long-Term Evolution (LTE) cell, and wherein the receiving of the bandwidth information comprises receiving the bandwidth information, plus information related to carrier aggregation capacity and Evolved Universal Terrestrial Radio Access (EUTRA)-New Radio (NR) dual connectivity (EN-DC) capability, in system information broadcasted by the network node.

20 **16.** The method of Claim 13, wherein the network node is associated with a Universal Mobile Telecommunications System (UMTS) or Global System for Mobile Communications (GSM) cell, and wherein the receiving of the bandwidth information comprises receiving a release version in system information broadcasted by the network node.

25 **17.** The method of Claim 12, wherein the selecting of one of the one or more RATs or one of the one or more neighbor network nodes comprises:

searching for a cell that supports Option 2 of 5th Generation (5G) network architecture responsive to the received information including information about one or more Option-2 New Radio (NR) cells in the region; or

30 searching for a Long-Term Evolution (LTE) cell responsive to the received information not including information about any Option-2 NR cell.

18. The method of Claim 12, wherein the selecting of the one of the one or more RATs comprises selecting a RAT among a plurality of access technologies defined in 3rd Generation Partnership Project (3GPP), 3rd Generation Partnership Project 2 (3GPP2), and Institute of Electrical and Electronics Engineers (IEEE) standards.

35 **19.** The method of Claim 12, further comprising:

receiving, by the processor, from the network node a dedicated signaling to the UE indicating presence of one other RAT or cell with higher performance than a current cell on which the UE is camped in terms of bandwidth, carrier aggregation, or both; and

40 performing, by the processor, a redirection or handover procedure to establish a connection with the other RAT or cell responsive to receiving the dedicated signaling.

20. The method of Claim 19, wherein the dedicated signaling comprises a redirection or handover command to the UE.

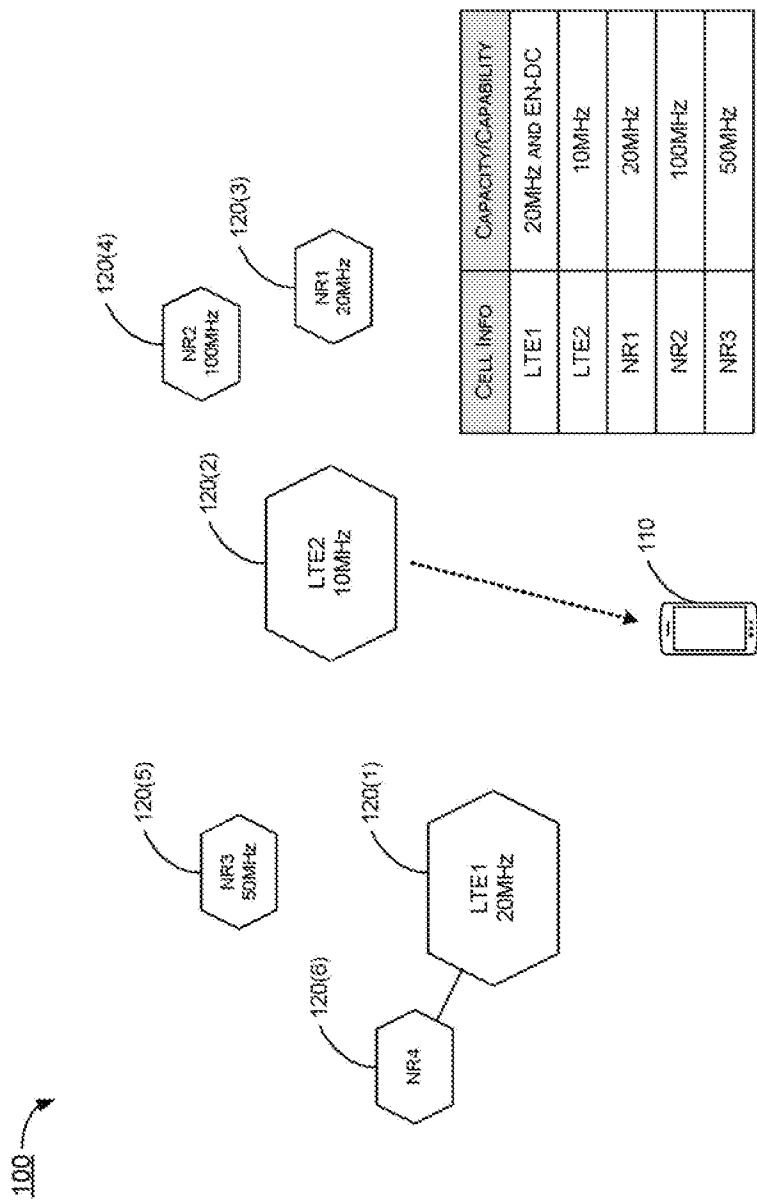


FIG. 1

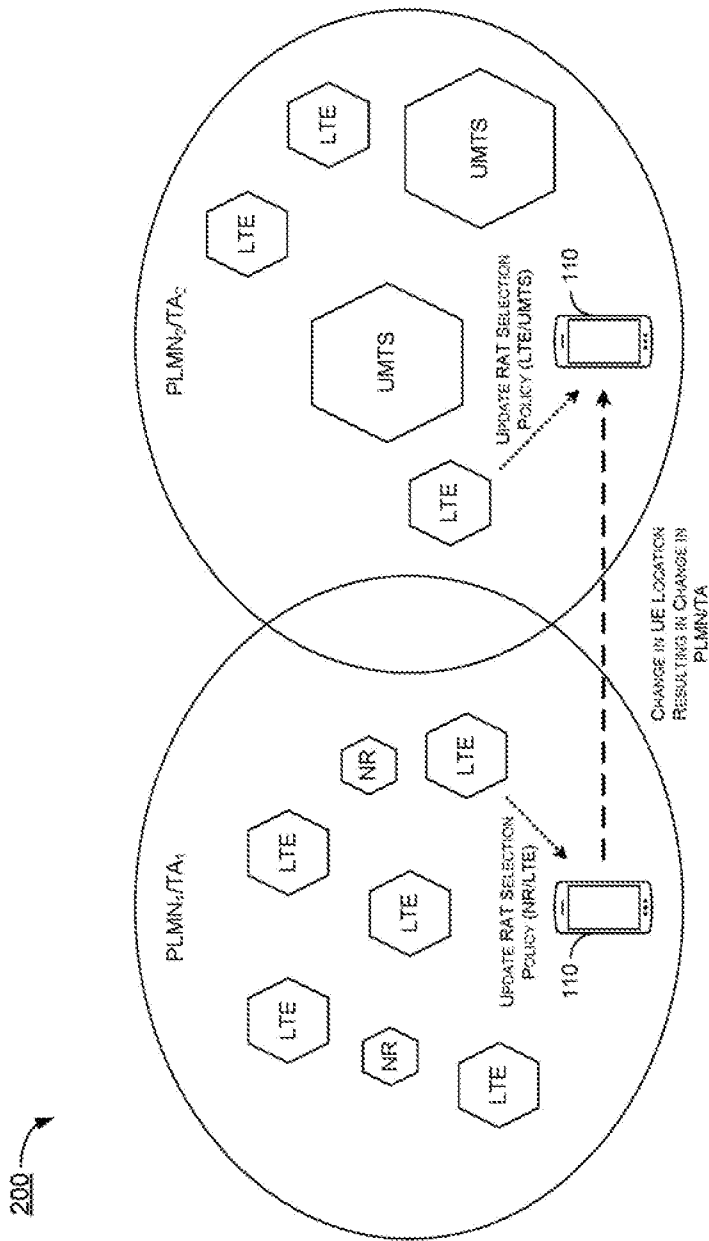


FIG. 2

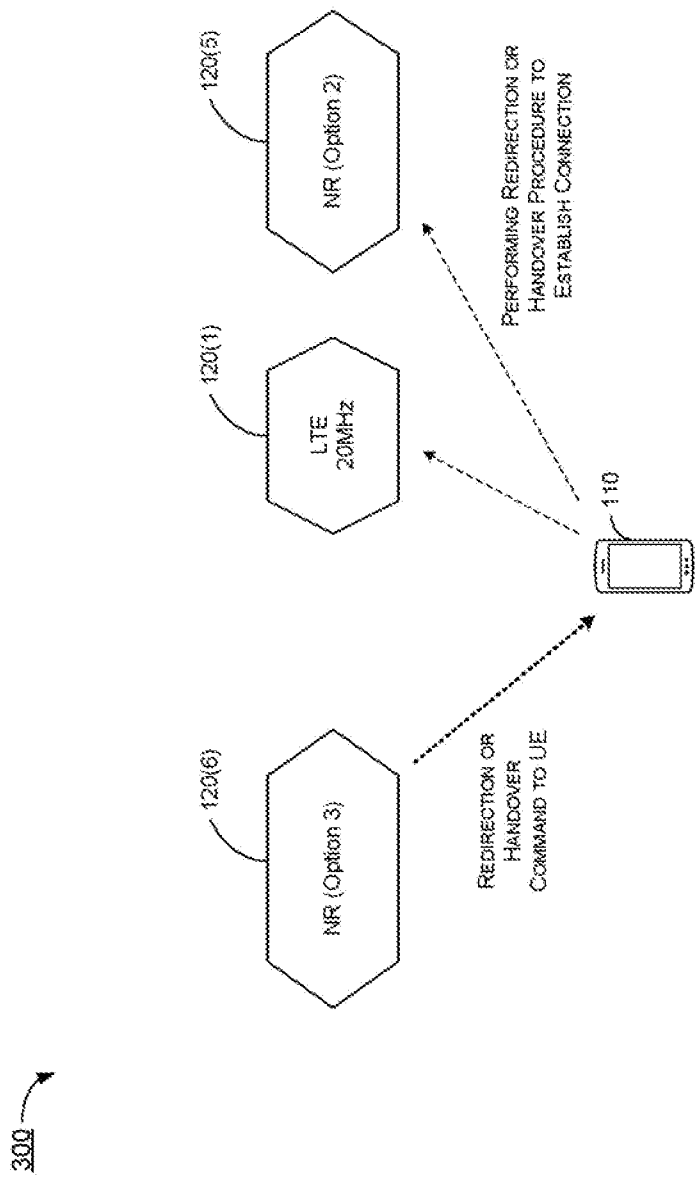


FIG. 3

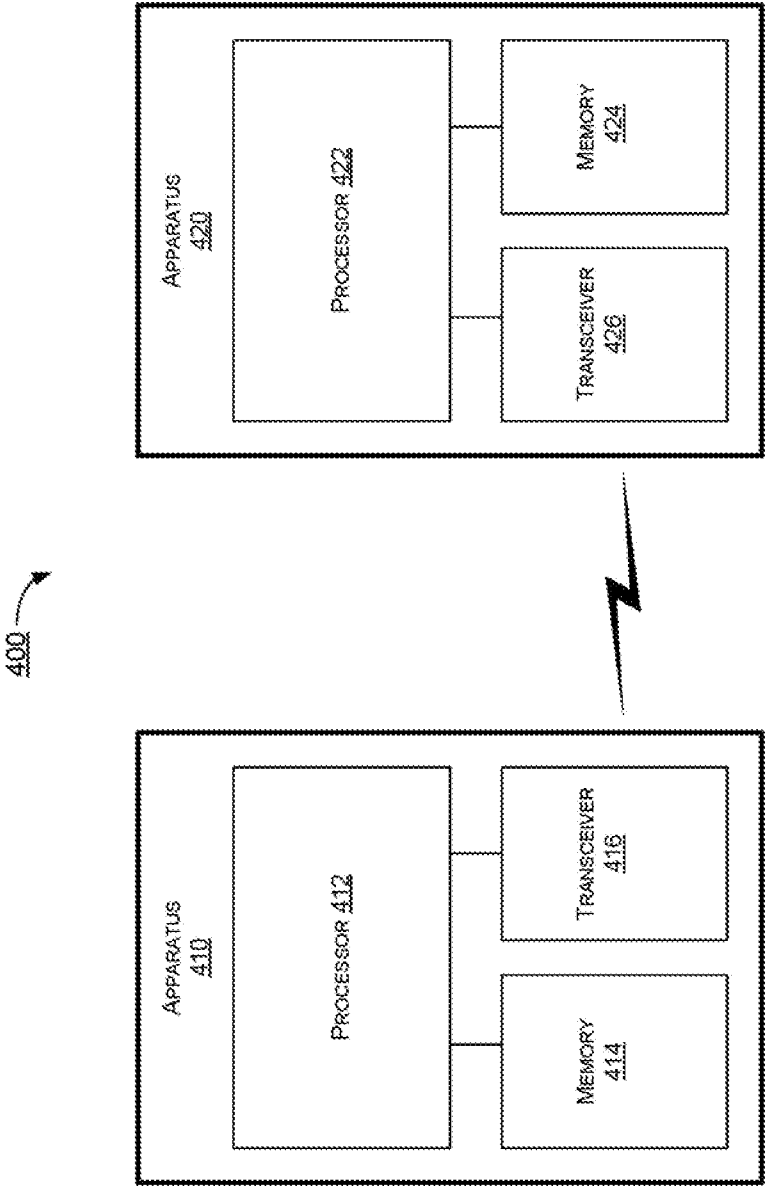


FIG. 4

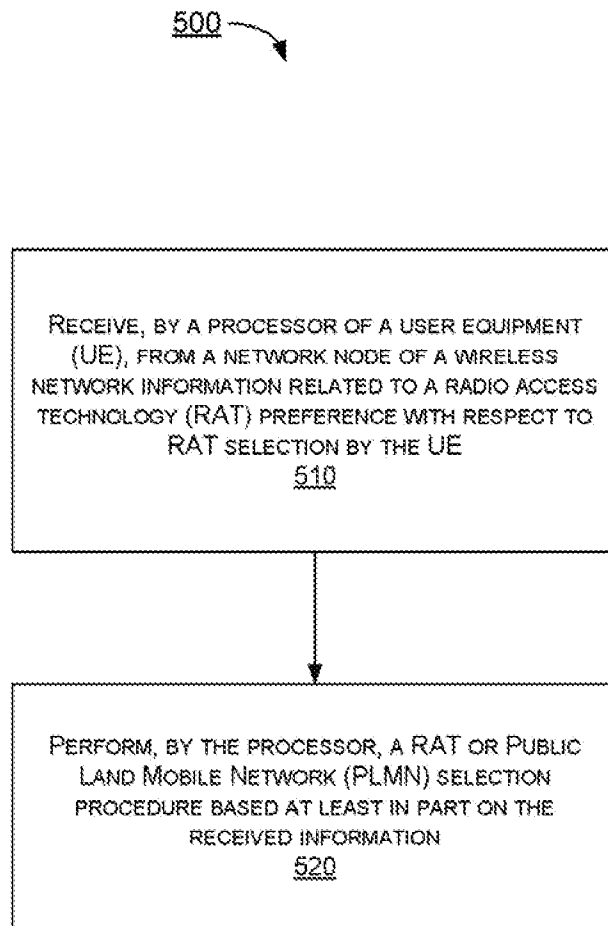


FIG. 5

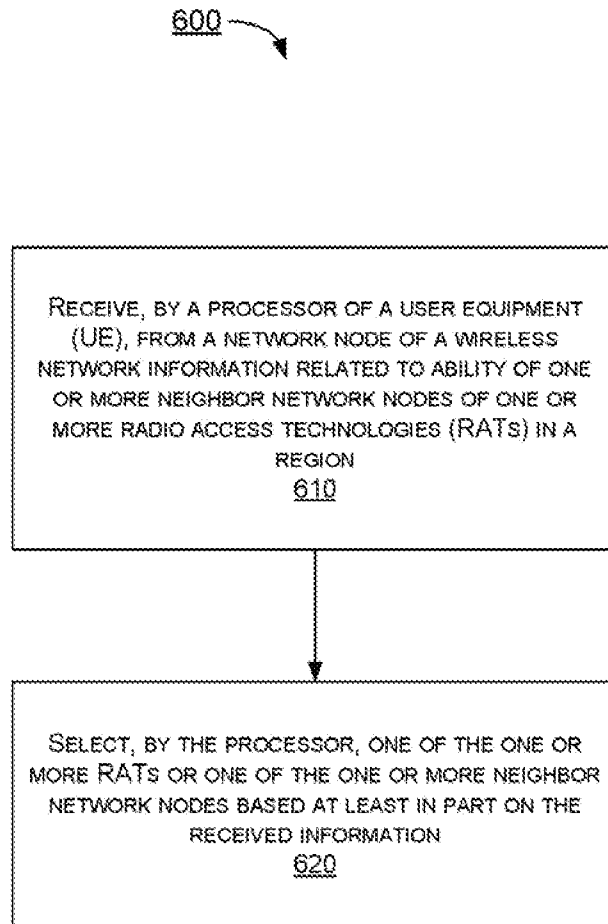


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/100218

A. CLASSIFICATION OF SUBJECT MATTER

H04W 48/16(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI;VEN;SIPOABS;CNABS;CNTXT;3GPP:RAT, radio access technology, PLMN, public land mobile network, 5G, select??, policy, 3GPP, NSA, non-standalone, SA, standalone, UE, terminal, user, preference

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102724736 A (RES INST TELECOMM TRANSMISSION MIIT) 10 October 2012 (2012-10-10) claims 1, description, paragraphs [0002]-[0034], and the abstract	1-20
X	CN 101895966 A (ZTE CORP) 24 November 2010 (2010-11-24) description, paragraph [0002]-[0012], the abstract	1-20
A	CN 103517325 A (ZTE CORP) 15 January 2014 (2014-01-15) the whole document	1-20
A	WO 2014114525 A1 (NOKIA SIEMENS NETWORKS OY) 31 July 2014 (2014-07-31) the whole document	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

27 October 2019

Date of mailing of the international search report

04 November 2019

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/100218

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	102724736	A	10 October 2012	CN	102724736	B	30 March 2016
CN	101895966	A	24 November 2010	None			
CN	103517325	A	15 January 2014	CN	103517325	B	04 May 2018
WO	2014114525	A1	31 July 2014	None			